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Socioeconomic status, anthropometric status, and psychomotor development of Kenyan children from resource-limited settings: A path-analytic study

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Abstract

Background: Sub-optimal physical growth has been suggested as a key pathway between the effect of environmental risk and developmental outcome.

Aim: To determine if anthropometric status mediates the relation between socioeconomic status and psychomotor development of young children in resource-limited settings.

Study design: A cross-sectional study design was used.

Subjects: A total of 204 (105 girls) children from two resource-limited communities in the Coast Province, Kenya. The mean age of these children was 29 months (SD=3.43; range: 24–35 months).

Outcome measure: Psychomotor functioning was assessed using a locally developed and validated measure, the Kilifi Developmental Inventory.

Results: A significant association was found between anthropometric status (as measured by weight-for-age, height-for-age, mid-upper arm circumference, and head circumference) and psychomotor functioning and also between socioeconomic status and anthropometric status; no direct effects were found between socioeconomic status and developmental outcome. The models showed that weight, height and to a lesser extent mid-upper arm circumference mediate the relation between socioeconomic status and developmental outcome, while head circumference did not show the same effect.

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Conclusion: Among children under 3 years living in poverty, anthropometric status shows a clear association with psychomotor development while socioeconomic status may only have an indirect association.

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Many children living in resource-limited settings have poor developmental outcome [1]. Sub-optimal physical growth is suggested as a key pathway between the effect of environmental risk and developmental outcome [2]. Using structural equation modelling, the current study investigates the mediational role of anthropometric status in the relationship between socioeconomic status and psychomotor development of children from a resource-limited setting.

Poor physical growth is prevalent in developing countries, where approximately 38% of children are underweight and 42% stunted [1], compared to approximately 2% and 1% being underweight and stunted in the USA [3]. The most vulnerable group of children with the highest prevalence of growth restriction are those under 5 years of age [4]. Growth restriction in the early years of life increases the risk of mortality [5], morbidity [6], and developmental delay and impairments [7–9].

Restricted social and economic resources have been associated with poor growth [10–12] and with poor developmental outcome [2,13]. The few studies that addressed the relationship between socioeconomic factors, growth, and psychomotor development consistently reported significant relationships between all three variables [14,15]. It is difficult to ascertain a causal link between poverty, growth, and outcome. The studies that were mentioned only addressed the correlation between the variables and did not investigate the potential pathways to poor developmental outcome. In the only path-analytic study of the relationship between socioeconomic status (SES), height-for-age (HAZ), and Motor Skills we identified, Pollitt and Walka [16] present a preliminary model of the relationship between the 3 variables among 12 and 18 month-old children in Indonesia. They report a significant relationship between SES and HAZ, and between HAZ and Motor Skills. However, this study addressed only direct effects and did not address more complex patterns of associations such as mediation. Partial mediation occurs if an input variable (e.g., socioeconomic status) influences the outcome both directly and indirectly through an intervening variable (e.g., HAZ). Full mediation is found when the input variable has only a link with the outcome variable through the intervening variable. We extend the findings from earlier reports by investigating whether the influence of SES (the predictor) on psychomotor development is partly or fully mediated by anthropometric status.

Each measure of anthropometric status applied represents a different form of nutritional deprivation and potentially different aetiology [17]. HAZ scores below -2 SD are associated with stunted growth, which in turn reflects chronic malnutrition. Weight-for-age (WAZ) scores below -2 SD are associated with low body mass, reflecting acute malnutrition, while head circumference-for-age (HCZ) is sensitive to the effects of chronic undernutrition, but is more closely related with genetic factors [18–20] and can be influenced by perinatal insults such as birth asphyxia. Mid-upper arm circumference-for-age scores (MUACZ) below -2

SD are associated with wasting which is an indication of acute malnutrition and severe growth disturbance.

The applicability of the model shown in Fig. 1 is tested for each measure of anthropometric status taken. The model holds that SES has both a direct and indirect effect on psychomotor development. This model is based on the hypothesis that children with lower SES experience a higher prevalence of poor anthropometric status and show less advanced psychomotor development than children from higher SES. Furthermore, children with poor anthropometric status are expected to have lower levels of psychomotor skills compared to those with normal anthropometric status.

1. Method

1.1. Study setting

The study took place at two sites. The first site was the Kenya Medical Research Institute, Centre for Geographic Medicine Research (Coast), Kilifi, Kenya. Kilifi is situated in a predominantly rural community. The majority of families depend upon subsistence farming with approximately (67%) of the population in the district living below the poverty line [21]. The majority of the population in Kilifi belong to the Mijikenda ethnic/linguistic group. Two Bantu languages are mostly spoken in the area, namely Kigirima (a member of the Mijikenda group of languages) and Kiswahili. A typical home in Kilifi comprises a large homestead with several small huts built in the compound. In these homes extended families live together and share in the daily chores such as cooking and fetching water. It is typical for homesteads to have members of three different generations where they share in childrearing duties. Intergenerational relationships are strictly regulated in this community [22]. For instance, parents largely play a disciplinary role and hence do not pay attention to children's play. Most of the time parents pay attention to children while administering functional duties such as feeding and washing. Children who have been weaned spend less time with the mother. These children will spend a large amount of time with older siblings who actively participate in child rearing. For instance, in this community only 35% of mothers keep their children within visual range when they are 24–35 months old; the rest of the time another person, often a sibling, carries out this role. The study took place within a demarcated area in Kilifi District that undergoes active, four-monthly demographic

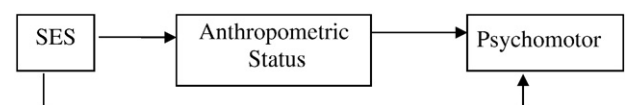


Figure 1 Hypothesized mediational model of the relationship between socioeconomic status (SES), anthropometric status, and psychomotor development.

surveillance, in which the births, deaths, and movements of individuals are recorded.

The second site was Kisauni location, a peri-urban site in Mombasa District. Mombasa is Kenya's second biggest city with a population of approximately 665,000 people [23]. In the Kisauni location approximately 47% of the population live below the poverty line, many live as squatters in informal settlements [24]. Compared to Kilifi, this site is much more metropolitan with a more diverse ethnic make-up. Kiswahili is widely spoken as a lingua franca. Most families live in single rooms as nuclear rather than extended families, sharing facilities such as the water source and toilets with other tenants. Furthermore, space is much more limited in Kisauni. In the absence of extended families mothers are much more vigilant; 70% of them indicated that they kept the children within visual range at 24–35 months. This may restrict child movements and range of play. Help for child care is largely provided either by a hired 'ayah' (maid) or an older sibling or neighbour.

1.2. Sample description

This study was part of a larger study carried out to develop a reliable and culturally acceptable infant monitoring programme, containing measures sensitive to the social and biological risks faced by children in resource-limited settings. The main study involved 423 children aged between 6 and 35 months. Children were identified and recruited through stratified random sampling. Stratification was based on age, gender, and location. In Kilifi, children were identified through a database maintained at the Centre, while in Kisauni village elders were used to identify households with eligible children. Children qualified for inclusion if they met the following criteria: a) aged between 24 and 35 months; b) their parents spoke either Kiswahili or a Mijikenda dialect as their primary language; c) they did not show chronic illness in the course of the study; d) their parents gave informed consent. All the children aged 24–35 months ($N=204$) in the main study were eligible for inclusion in this study. We focused on this age group for several reasons. By 24 months of age the influence of environmental factors becomes more prominent [25] and the height of children below the age of 2 years is measured recumbent, while the older group is measured standing. This change in measuring method may lead to an overestimation of growth problems in an age group when both age groups are included in one analysis. Concentrating on one group may reduce this bias. The sub-sample studied here included 204 children (105 girls). The mean age of these children was 29 months ($SD=3.49$; range 24–35 months).

1.3. Measurements

1.3.1. Kilifi Developmental Inventory

This scale is part of a locally developed and validated measure of infant development. The KDI consists of 69 items, scored from observation of children's performance on a range of activities [26,27]. An assessor initially provides instructions and demonstrations for the child to model. A sum score is calculated for two functional areas, locomotor skills and eye–hand coordination. These can also be combined to provide an overall psychomotor score. Locomotor items assess

the child's movement in space, static and dynamic balance, and motor coordination. Items include ball and reaching skills, mobility in prone position, supine position and standing, development in climbing, and jumping. Eye–hand coordination assesses the child's ability to manipulate objects and to co-ordinate fine motor movement. Items include manipulation of coins, bead threading and block building. Items were scored on a dichotomous scale (0: child cannot perform the task, 1: child can perform the task). Table 1 summarizes the psychometric properties of this measure in the current sample while Appendix A presents a brief description of the items in the inventory.

1.3.2. Socioeconomic status

Two SES measures were used, wealth index and maternal education, to determine whether they had different relationships with anthropometric status and psychomotor outcomes. Wealth was measured using an index adapted from the Kenya Demographic Health Survey SES questionnaire [28]. A single score was generated through principal component analysis. To take into account local variations in environmental factors only the 13 items from the original study were retained that showed variation within this population and had a salient loading on the one-factor solution found in a factor analysis of the items. A higher factor score indicated a higher SES. Table 2 presents a summary of items included, spread of scores and their factor loadings. Maternal education was operationalized as the number of years the mother attended formal schooling. The mean maternal education in this population was approximately 4.81 years of schooling ($SD=3.95$; range: 0–14 years).

1.3.3. Anthropometrics

Height was measured standing, using a Leicester Height measure. Two trained assistants following the CDC recommended protocol for taking height measurements took the measures. Children were undressed and weighed on a SECA Digital Scale. Weight was recorded following at least three measures that provided a consistent result to at least one decimal point. Weight-for-Age and Height-for-Age standards were generated using the WHO 2005 software for assessing

Table 1 Psychometric characteristics of the Kilifi Developmental Inventory

Statistics	N	Locomotor	Eye-hand	Psychomotor
Maximum possible score	35	34	69	
Means (SD)	204	22.48 (2.96)	26.52 (3.26)	49.00 (5.59)
Alpha	204	0.76	0.78	0.86
Retest reliability (ICC)	42	0.61	0.80	0.83
Correlation with age(r)	204	0.42**	0.62**	0.59**
Correlation with gender ^a	204	0.01	0.06	0.03

SD: Standard deviation. ICC: Intraclass Correlation Coefficient (Consistency). N: Sample size. ** $p<0.01$.

^a Gender coding: girl=1, boys=0.

Table 2 Items in the SES measure

	Percent of population in each category of ownership (key below)				Factor loading
	0	1	2	3	
Radio	45.1	54.9			0.35
Telephone	79.3	20.7			0.43
Bicycle	62.2	37.8			0.45
Electricity	82.4	17.6			0.56
Television	82.4	17.6			0.58
Availability of water ^a	21.2	78.8			0.58
Type of window ^b	29.0	9.8	59.1		0.64
Availability of toilet facilities ^c	31.1	71.0			0.69
Livestock ^d	59.1	27.5	13.5		0.72
House ownership	38.3	61.7			0.75
Land ownership	38.3	61.7			0.75
Roofing materials ^e	45.1	54.9			0.75
Material used on the floor of the house ^f	58.5	41.5			0.85

^a Key: 0=Access to water in >15 min; 1=Access to water in <15 min.

^b 0=no window; 1=Open window; 2=all other windows (e. g., mesh wire, glass).

^c 0=no toilet and uses the bush; 1=Toilet facilities available.

^d 0=none; 1=some; 2=many.

^e 0=Thatched roof, 1=All other roofing materials.

^f 0=lives in a house with a mud floor; 1=lives in a house with other types of floor materials.

growth and development 2006 version [29]. Growth restriction was defined as having a score below -2 SD of the WHO 2005 standards. For head circumference and mid-upper arm circumference, these new data were not available and therefore EPI info (3.3.2) and the WHO/CDC 1978 reference were used to compute the z scores.

1.4. Procedure

Children were seen at home accompanied by their primary caretakers. A team of two experienced assessors, trained in the assessment procedures prior to the data collection process, carried out the assessment of developmental outcome and took anthropometric measures.

1.5. Data management and analysis strategies

Data were double entered in FoxPro and verified before being transferred to SPSS (version 12) for analysis. A *t*-test was used to compute group differences while Cohen's *d* was used to estimate effect sizes. Amos 5 [30] was used to compute the goodness of fit of the hypothesized path model. The fit of the overall model was evaluated using the chi square statistic, which tests the exact fit of the model, as well as various other fit indices such as the Root Mean Square of Approximation (RMSEA), which measures the discrepancy between the predicted and observed models per degree of freedom and the Tucker Lewis Index (TLI), which measures the similarity of the observed and hypothesized covariance

matrix, adjusted for model complexity. We used full information maximum likelihood estimation to accommodate missing SES data for 11 children. The model was tested with and without the subjects with missing data. Similar findings were observed and therefore we report data with all subjects included.

1.6. Ethics

The Kenya Medical Research Institute National Scientific and Ethical Committees approved the study. Written informed consent was obtained from all families and guardians of study participants. The consent form was read out to illiterate participants in the language with which they were most familiar before signing the consent form. Prior to getting individual consent, we held a series of meetings with elders and leaders within the communities to inform them of the study and get their permission and cooperation in working in these communities.

2. Results

2.1. Anthropometric status

Approximately 49% ($N=100$) of the children were stunted, and 19.6% ($N=40$) were underweight as measured by HAZ and WAZ scores below -2 SD, respectively. Results indicate that rural children were more likely to be stunted (57%) than urban children (41.3%) were. A Pearson chi square test showed that this difference was significant ($\chi^2(1, N=204)=4.99, p=0.03$). The difference in percentage of children who were underweight was not significantly different for the urban and rural group (rural: 23%, urban: 16.3%; $\chi^2(1, N=204)=1.43, p=0.23$). Head growth did not differ in the two groups either; poor head growth was found in 9.6% of the urban and 6% of the rural children ($\chi^2(1, N=204)=0.92, p=0.34$). Furthermore,

Table 3 Means and standard deviations on Kilifi Developmental Inventory psychomotor score for children with and without growth restriction

	<i>N</i>	<i>M</i> (SD)	<i>t</i> ^a	<i>p</i>	Cohen's <i>d</i>
<i>Height</i>					
Stunted	100	−0.39 (1.03)	3.74	0.000	0.52
Normal height	104	0.11 (0.90)			
<i>Weight</i>					
Underweight	40	−0.67 (0.97)	−3.94	0.000	0.70
Normal weight	164	−0.00 (0.96)			
<i>Head circumference</i>					
Small head size	16	−1.04 (1.09)	−3.91	0.000	1.02
Normal head size	188	−0.06 (0.95)			
<i>MUACZ</i>					
Poor MUACZ	26	−0.74 (1.01)	−3.40	0.001	0.72
Normal MUACZ	178	−0.05 (0.96)			

^a *t*-test has 202 degrees of freedom.

Table 4 Correlations between the key variables

	1	2	3	4	5	6
1 Wealth	1					
2 Maternal education	0.54**	1				
3 Psychomotor scores	0.02	0.09	1			
4 Weight-for-age	0.25**	0.24**	0.21**	1		
5 Height-for-age	0.31**	0.29**	0.29**	0.72**	1	
6 Head circumference	0.06	0.09	0.18*	0.48**	0.36**	1
7 MUACZ	0.19**	0.18**	0.14*	0.72**	0.37**	0.31**

* $p < 0.05$. ** $p < 0.01$. MUACZ: Mid-upper arm circumference-for-age.

the percentage of children with poor MUACZ did not differ for the urban and rural group (rural: 16.2%, urban: 9.1%; $\chi^2(1, N=204)=2.31$, $p=0.13$). We did not observe any significant gender differences in anthropometric status. We therefore excluded gender from any further analysis.

2.2. Growth restrictions and psychomotor performance

We first tested whether children with and without growth restrictions showed different psychomotor scores. As can be seen in Table 3, the effects of growth restrictions were considerable. Children with growth restrictions on HAZ, WAZ, MUACZ or head circumference-for-age showed a significantly lower psychomotor score than children in the reference group. The effect size was large for head circumference-for-age and moderate for the other growth measures.

2.3. Relationship between SES, HAZ, and performance

Table 4 presents the correlations between all variables that were included in our path analysis. In the first model, the wealth index was included as the SES indicator. The hypothesized model (with paths from SES to HAZ, from HAZ to Performance, and from SES to Performance) was modified since the path coefficient between SES and psychomotor development was not significant ($\beta = -0.08$, $p = 0.26$). A new model without a direct path between SES and psychomotor development was then tested. The modified path-analytic model showed a non-significant chi square fit value which points to a good fit (see Table 5). Furthermore, other fit indices were also within acceptable range [31]. The model indicates that SES is positively associated with height (standardized $\beta = 0.31$), which in turn is positively associated with psychomotor skills ($\beta = 0.29$).

The second path model used maternal education as the SES indicator. Similar patterns of relationships between the variables as in the previous model emerged, with the path coefficient between maternal education and psychomotor development being non-significant ($\beta = 0.00$, $p = 0.97$). As can be seen in the table, the modified path-analytic model showed a non-significant chi square fit value which points to a good fit of the predicted and observed relationships (Table 5).

2.4. Relationship between SES, WAZ, and performance

The hypothesized model (with the same paths as in the previous section, but now for WAZ instead of HAZ) was also modified to take into account the non-significant path coefficient found between SES (wealth index) and psychomotor development ($\beta = -0.03$, $p = 0.79$). A new model without a direct path between SES and psychomotor development was

Table 5 Summary of standardized regression coefficients and fit indices of the path models

	β (SES/maternal education–anthropometry)	β (Anthropometry–outcome)	χ^2 ^a	P	TLI ^b	RMSEA
HAZ						
Wealth index	0.31**	0.29**	1.25	0.26	1.00	0.00
Maternal education	0.29**	0.29**	0.01	0.97	1.00	0.02
WAZ						
Wealth index	0.25**	0.21**	0.19	0.66	1.00	0.00
Maternal education	0.24**	0.21**	0.31	0.58	1.00	0.00
HCZ						
Wealth index	0.06	0.18**	0.02	0.88	1.00	0.00
Maternal education	0.09	0.18**	1.07	0.30	0.96	0.02
MUACZ						
Wealth index	0.19**	0.14 ⁺	0.01	0.96	1.00	0.00
Maternal education	0.18**	0.14 ⁺	0.82	0.37	1.00	0.00

HAZ: Height-for-age, WAZ: Weight-for-age, HCZ: Head circumference-for-age, MUACZ: Mid-upper arm circumference-for-age, TLI: Tucker Lewis Index, RMSEA: Root Mean Square Error of Approximation.

** $p < 0.001$. ⁺ $p = 0.051$.

^a 1 degree of freedom.

^b All TLI values above 1 were reported as having a value of 1.

then tested. Like the model with HAZ, the path-analytic model showed a non-significant chi square fit value and appropriate other fit indices which support a good fit of the predicted and observed relationships (see Table 5). The model indicates that SES is positively associated with WAZ ($\beta=0.25$), which in turn is positively associated with psychomotor skills ($\beta=0.21$). Additionally, the same model as specified above was fitted with maternal education as the SES indicator. As can be seen from the table of regression coefficients similar patterns as the ones seen with the Wealth Index emerged, with the path coefficient between maternal education and psychomotor development being non-significant.

2.5. Relationship between SES, head-circumference-for-age, and performance

The chi square fit value of the model was non-significant which points to a good fit. However, unlike the model for height-for-age and weight-for-age, SES (wealth index and maternal education) had a non-significant association with head circumference, while the latter is positively associated with psychomotor skills.

2.6. Relationship between SES, MUACZ, and performance

The chi square fit value of the model with the SES (wealth index and maternal education) was non-significant, which points to a good fit; yet, MUACZ was strongly associated with SES ($\beta=0.19$, $p<0.001$) while MUACZ had a marginally significant association with psychomotor development ($\beta=0.14$, $p=0.051$). A similar pattern of results was observed when the SES indicator was maternal education.

3. Discussion

Consistent with previous studies we found a relationship between SES indicators and HAZ, WAZ, and MUACZ [32–35]. We also found that anthropometric status was significantly correlated with psychomotor performance which is consistent with earlier reports [36–38]. The psychomotor performance of children experiencing poor physical growth ranged from moderate delay for stunting, being underweight and MUACZ, to severe delay for those with poor head growth, as indicated by the value of Cohen's d . These results indicate that poor head growth results in significant developmental delays and impairments that warrant intervention measures. The effects of stunting and being underweight are much more subtle; still, ignoring these smaller effects can create major problems at the community level due to the cumulative loss in human potential in a salient percentage of the population.

The pattern of relations between SES indicators (wealth index and maternal education) and psychomotor functioning indicates that anthropometric status fully mediated the influence of SES on developmental outcome. SES had a significant effect on psychomotor development through its influence on the three intervening variables (HAZ, WAZ and MUACZ). The observed relationship can be interpreted within the framework of a bio-ecological perspective [39]. This theoretical framework holds that a child grows up in layered

environments, ranging from proximal factors (in our case anthropometric status) to distal factors (SES). Distal factors define the context for proximal factors (e.g., SES impacts on anthropometric status); proximal factors have more impact on developmental outcome than have distal factors (e.g., anthropometric status has stronger association with psychomotor development compared to SES). This emphasizes the need to investigate and interpret influences on child well-being using a multi-level approach.

Head circumference-for-age did not show the same pattern of a significant relationship with SES as HAZ, WAZ and MUACZ. The lack of relationship between head circumference-for-age and SES might be explained by the relatively larger contribution to variance in head size of genetic factors, as evidenced by the strong association between parent and child measurements [20]. The association may mean that head circumference is the anthropometric measure that is less susceptible to influences of social and economic factors. Also, we cannot exclude that some of these children have had perinatal insults, since recall of perinatal events is poor in this community [40].

We found a high prevalence of retarded growth among toddlers in our population, especially in the rural subgroup. Furthermore, the mean scores of all anthropometric measures were below those of the reference data. Both results are consistent with earlier studies in Kenya [15,41]. This high prevalence of growth restriction and poor psychomotor development indicate that the multiple risks experienced by children from the lower socioeconomic strata in Kenya may lead to a generally suboptimal growth in this population. There is a need to pay more attention to antecedents and consequences of poor physical growth in resource-limited settings.

The importance of monitoring growth in an infant population lies in the observed adverse impact of poor growth on psychomotor development. Additionally, early psychomotor development is a building block for later skill development. In the first 2 years of life, children acquire knowledge and skills through sensori-motor exploration of their environment. Problems in psychomotor development in the early years can negatively impact on other aspects of child development since motor skills support maturity in other areas such as social and communication skills [42]. In fact, earlier studies with undernourished children indicate that the effects of undernutrition on locomotor development is the main pathway to other developmental deficits [43].

Earlier studies had reported the existence of a significant association between anthropometry, socioeconomic status and developmental outcome. More recently, Walka and Pollitt [16], working in Indonesia, presented a preliminary model for studying the relationship between the three variables. We extend their model and showed that the relationship between SES and outcome is fully mediated by WAZ and HAZ. The full mediation rules out the existence of a direct relationship between SES and outcome [44], which may explain some of the earlier results from Africa that reported an absence of relationship between most of the SES indicators and infant development [25,45–47]. Our results contribute to a greater understanding of the role of socioeconomic indicators in developmental psychology in a resource-limited setting.

The two SES indicators used in this study (wealth index and maternal education) showed essentially identical associations with anthropometric measures and psychomotor scores. These findings suggest their substitutability from a psychological perspective. More wealth in the family and more maternal education are both associated with better anthropometric status and through this variable with a better psychomotor status. The substitutability of maternal education and wealth in our models points to the global influence of SES. A close analysis of the associations between the various measures included in the wealth index and anthropometric status suggested that no single measure is responsible for the SES effect, but that SES points to a global cluster of modernity-related constructs. Earlier studies in non-western settings also had indicated that westernization and modernization influence childrearing practices which in turn influence the acquisition rate of psychomotor skills. In an extensive literature review, Werner [48] indicates that after controlling for aspects such as birth weight and weaning (which influences protein intake especially in those living in poverty), there is a unique and distinct influence of westernization vs. traditional rearing practices on motor outcomes. An interesting question for future studies to examine is whether more direct measures of child stimulation and environmental learning opportunities than provided by our SES measures would also show a direct relationship with psychomotor status.

Our study has a two-fold limitation. Firstly, the cross-sectional design does not enable us to draw conclusions about the possible dynamic age-dependent effects of physical growth. Future studies using a longitudinal design are needed to investigate this relationship further. Secondly, the model tested included only a limited range of potential antecedent variables, other distal influences such as maternal age, maternal IQ, and parenting behaviour may provide additional useful data to consider in the design of interventions, and to clarify further the role of SES in early child development.

Research indicates that the negative effects of poor growth can be reversed or at least minimized through early intervention [49–52]. Our study suggests that in resource-limited contexts, interventions aimed at facilitating physical growth in children with poor growth outcomes will potentially have a significant effect on psychomotor development. Furthermore, the results provide further empirical evidence from SSA which suggest that interventions among infants in resource-limited settings need to transcend the conventional disciplinary boundaries and should address both physical health and motor as well as psychosocial functioning [53–55].

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Appendix A

A Brief description of the Kilifi Developmental Inventory^{1,2}

Scale	Sample of skills assessed	Example of items
Locomotor	Movement in space	Walks backwards with support or for less than length of mat
	Static balance	Stands on one leg, without support for 10–20 s
	Dynamic balance	Hops on one leg for length of mat
	Motor coordination	Jumps off platform and lands on both feet
Eye–hand coordination	Supine position	Rolls from side to back
	Co-ordination of fine motor movements	Threads 2 beads onto shoe lace
	Reaching skills	Reaches for dangling ring
	Development of grasp	Grasps red tassel successfully
	Object manipulation	Can hold and examine object (ring, bear etc)

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¹ Some differences and similarities between KDI and Bayley

- KDI does not have any items assessing verbal skills. We do have separate measures for this.
- We do not have a mental and motor scale separate; we prefer to refer to the scale as psychomotor in view of the fact that most of motor actions are invariable having a cognitive component.
- Do not have the object permanence items instead we have separately an adapted version of the Piagetian object permanent task.
- We removed items with unfamiliar stimulus such as stairs and picture books.
- Yet there are still many similar tasks such as block building, pen and pencils task, bead threading, and container cube tasks.

² Interested readers can contact the first author for a copy of the Kilifi Developmental Inventory.

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